Feasibility of Using a Second Unit Load Size for Distributing Groceries: From Supplier to Distribution Warehouse

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PREFACE

This study is part of a continuing research program in the Agricultural Marketing Research Institute designed to find more efficient and less costly systems for handling agricultural products from producer to consumer.

Appreciation is expressed to the grocery suppliers and wholesale-retail food distribution companies that made their facilities available to determine labor, equipment, space, and material costs for handling unitized grocery products and to the Paul F. Shaffer Co., management consultants, Miami, Fla., for conduct of the study under contract. Lizabth Deatrick, associate, Paul F. Shaffer Co., assisted in data acquisition and analysis.

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CONTENTS

FEASIBILITY OF USING A SECOND UNIT LOAD SIZE FOR DISTRIBUTING GROCERIES: FROM SUPPLIER TO DISTRIBUTION WAREHOUSE

By J. C. Bouma and P. F. Shaffer[1]

ABSTRACT

Total supplier costs (unitization, storage, in-plant transportation, and materials) were $99.71 per 1,000 cases when only the standard 48- by 40-inch pallet was used. The supplier costs for addition of a smaller (40- by 32-inch) pallet were $143.23 per 1,000 cases, or an increase of $43.52. Product handled without pallets by use of clamp lift truck in the standard unit load size cost $86.57 per 1,000 cases, whereas the cost for handling the smaller unit load size was $133.63, an increase of $47.06. Transportation costs between the supplier and distribution warehouse were not found to increase. The added supplier costs compare with a cost of $6.00 per 1,000 cases to repalletize product from 48- by 40-inch to 40- by 32-inch unit loads at the warehouse. Therefore, it is a more economical system for warehouse distributors to repalletize product than for suppliers to handle two unit load sizes.

KEYWORDS: Supplier, supplier costs, unitization, unit load, pallet, handling costs, distribution warehouse, transportation, system.

INTRODUCTION

Many warehouse distributors of dry groceries are concerned about the need to repalletize groceries received on standard 48- by 40-inch unitized pallets or slipsheets. These distributors are not able to accommodate all of the items they receive on standard pallets within their existing warehouse selection line space and find it necessary to store items on smaller (40- by 32-inch) pallets.

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In a recently completed study,2/ an evaluation was made of five methods of shipping groceries from supplier plant to distribution warehouse. The 48- by 40-inch unit load, which is the standard for the grocery industry, was used in all shipments. The adoption of the standard size unit load did not solve all the handling problems, however. Of the six distribution warehouses included in this earlier study, the majority used both the standard pallet and a second 40- by 32-inch pallet for storage. When unit loads were received that were to be stored on 40- by 32-inch pallets, it was necessary to repalletize the cases; 26 percent of the cases received unitized were repalletized on 40- by 32-inch pallets at a cost of $6 per 1,000 cases.

This earlier study also showed that two firms with annual volumes of 4.3 and 20 million cases stored 41 and 46 percent, respectively, of their items on 40- by 32-inch pallets. However, their annual case volume movement of merchandise on the small pallets accounted for only 20 and 10 percent of their volume. The remaining merchandise was stored and shipped from the 48- by 40-inch pallet.

Some of the managers of the warehouses using two pallet sizes for storage believe supplier shipment on two unit load sizes would be less costly than the repalletization. Many large food warehouses solved the repalletization problem by converting to total storage on the 48- by 40-inch pallet. This was achieved at a cost of $26 (see footnote 2) per 1,000 cases for additional space and racking.

OBJECTIVES

The first objective of this study was to measure the supplier costs and determine the advantages and disadvantages of using a 40- by 32-inch unit load in addition to the 48- by 40-inch unit load in the grocery distribution system. The second objective was to compare space utilization in loading of transport vehicles and project costs associated with the out-of-plant transportation of two unit load sizes.

METHODOLOGY

Labor, equipment, space, and material costs were developed in two supplier plants, one with storage and handling on pallets and the second without pallets. Costs for equipment, space, and materials were obtained from cooperator records.

2/ Bouma, J. C., and Shaffer, P.F. Systems for handling grocery products from supplier to distribution warehouse. U.S. Dept. Agr. Mktg. Res. Rpt. 1075, 44 pp. 1978.

It was necessary to simulate the effects of introduction of a second unit load size on space and pallet utilization from measures obtained in retail food warehouses. Transport vehicle utilization data were obtained by studying existing methods in truck transportation and by simulation in rail transportation.

HANDLING IN THE SUPPLIER PLANT

Four cost elements are associated with use of two pallet sizes in supplier plants: unitization, storage, transportation, and material costs. Each of these cost elements will be discussed.

Unitization

At the supplier plant, the cases of product are unitized by an automatic "palletizer" at the end of the production line. This unitization is maintained for subsequent handling whether pallet or palletless handling and storage systems are used. There are two approaches to adding a second size unit load at the automatic palletizer: to change from one unit load size to another during each product run, or to add a second automatic palletizer and case diverter to each production line. To change over to a different unit load size during each production run with just one palletizer has the advantage of lower equipment and space costs. However, it would be more difficult to maintain the right inventory balance between the two unit load sizes when there are long production runs. An additional problem with only one palletizer is lost production, since 3 to 5 hours are required for two men to adjust the automatic palletizer; to maintain production, labor would be required to handstack merchandise during the changeover. The use of a second palletizer and diverter for each line would allow the supplier to change the ratio of product on the two unit loads and thereby help keep his production and inventory in balance. Suppliers, although opposed to either alternative, would prefer a palletizer for each unit load size on each production line. A second unit load size would increase the cost for both pallet and palletless unitization by $15.53 per 1,000 cases as shown in table 1.

Storage

The use of palletless storage in supplier plants is increasing with the development of different methods of unitized shipment to grocery distribution warehouses. With palletless storage a forklift truck with a clamp attachment is used to transport the unit load directly from the palletizer/unitizer to storage. The palletless unit loads are normally 48- by 40-inches (the 40- by 32-inch unit load is an added consideration in this study). When unit loads of product are shipped on pallets, the product is typically placed on a pallet by the palletizer at the production line and stays on pallets in storage. Because both pallet and palletless storage are still used, cost analyses were developed for both methods.

Table 1.--Cost for unitization with 1 and 2 unit load sizes1/

Cost element	1-size load	2-size load
	Dollars	Dollars
Annual palletizer cost	10,740	21,480
Cost per 1,000 cases at 125 cases per hour	14.32	28.64
Cost per 1,000 cases for case diverter	--	1.21
Total unitization cost per 1,000 cases	14.32	29.85

1/ For detailed depreciation and cost allocation per 1,000 cases, see appendix table 9.

Pallet Storage

A key factor in the cost consideration is the relative capacity of the two pallet sizes. The 48- by 40-inch pallet has 50 percent more space than the 40- by 32-inch pallet. It was anticipated that the larger the area, the more effective the utilization of space. To determine the relative capacity of the two unit loads, a study was made of the tie or layer pattern for 49 items that were stored on both sizes of pallets in food distribution warehouses. As shown in appendix table 10 the 48- by 40-inch pallet held an average of 12.08 cases per layer, or 55 percent more cases, than the 40- by 32-inch pallet, which averaged 7.80 cases per layer. This indicates the standard pallet has a slightly greater relative capacity(5 percent) than the small pallet, and this larger capacity is advantageous in the supplier plant for storage and handling. For purposes of this study, the average capacity of 48- by 40-inch pallets is 60 cases. Based on the above survey (table 10) the capacity of 40- by 32-inch pallets would be 39 cases (60 divided by 1.55).

Pallet storage racks are designed to hold two 48- by 40-inch pallets or three 40- by 32-inch pallets on the cross bars of each 9-foot-wide bay. The only advantage of using the standard pallet exclusively for storage in the supplier plant is the 5 percent capacity advantage. As shown in table 2, the storage cost for addition of a 40- by 32-inch pallet would increase costs $0.68 per 1,000 cases.

Palletless Storage

Palletless storage has the advantage of eliminating space required for the pallet and pallet rack. However, the height to which many groceries can be stacked is limited without the support provided by a pallet and pallet rack base. For example, product could be stacked six pallets high in one plant using pallet

storage and only four unit loads high in another plant using palletless storage. Similarly, in palletless storage it was found that while 48- by 40-inch unit loads of product could be stored four unit loads high, 40- by 32-inch unit loads of product could be stored only three unit loads high. Thus, the larger pallet base provides greater stability.

In this study it was found that merchandise handled in palletless storage on 48- by 40-inch unit loads averaged 55 cases per unit load and 40- by 32-inch unit loads averaged 35 cases. A storage bay 46 inches wide (40 inches for the unit load and 6 inches clearance for the clamps) by 32 feet deep will accommodate eight unit loads on the floor. By stacking unit loads four high, storage capacity will total 1,760 cases (32 unit loads times 55 cases). The same size storage bay will accommodate 40- by 32-inch unit loads 12 deep and 3 high for a total capacity of 1,260 cases (36 unit loads times 35 cases). A storage bay perspective with the two unit load sizes is shown in figure 1.

In addition to the actual storage space, 46 inches wide by 32 feet deep, space must also be provided for access aisles at the front and rear of the storage bay. Access aisles are 11.5 feet wide, and one-half of the aisle space must be assigned to the storage bay on each end. The actual storage bay dimensions are 43.5 feet deep by 3.833 feet wide or 166.75 square feet. As shown in table 3, storage costs total $16.58 per 1,000 cases for 40- by 32-inch unit loads.

Table 2.--Supplier storage costs with standard and small pallet sizes

Element	Pallet size			
	48 by 40 inches		40 by 32 inches	
	Number	Dollars	Number	Dollars
Space rental per 85.6 square-foot bay, at $1.75 per square foot	--	149.80	--	149.80
Cases per pallet	60	--	39	--
Pallets per bay	12	--	18	--
Annual case storage at 10 stock turns	7,200	--	7,020	--
Annual space cost per 1,000 cases	--	20.81	--	21.34
Annual pallet rack cost per 1,000 cases 1/	--	5.83	--	5.98
Total cost per 1,000 cases for space and racks	--	26.64	--	27.32

1/ Based on installed rack cost of $415, annual cost is $42.00 including interest and depreciation divided by annual case storage of 7,200 cases with standard pallets and 7,020 cases with small pallets.

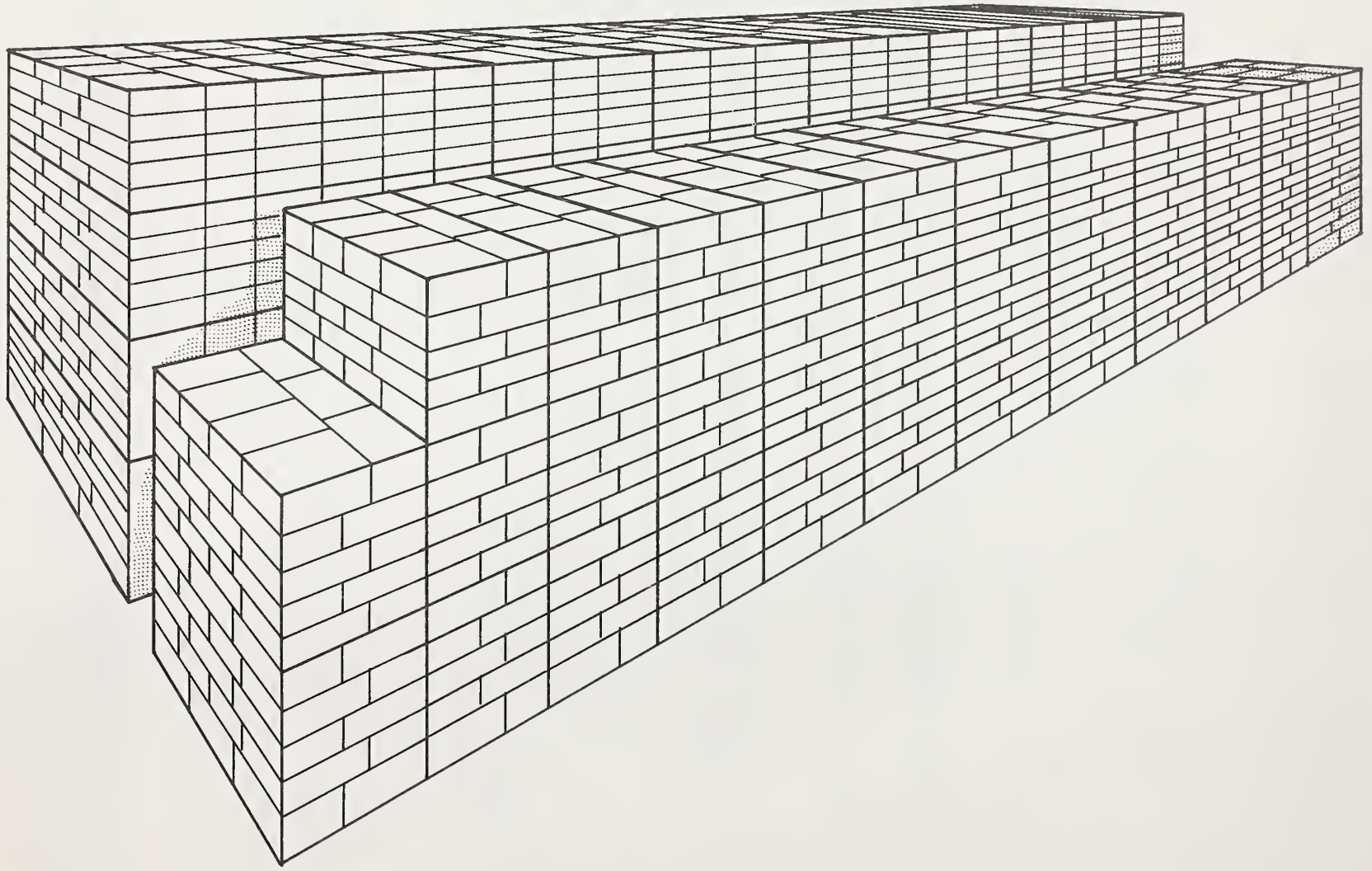

Figure 1.--Perspective of storage bays with 48- by 40-inch and 40- by 32-inch palletless storage.

Table 3.--Supplier storage costs with standard and small unit load palletless storage

Element	Unit load size			
	48 by 40 inches		40 by 32 inches	
	Number	Dollars	Number	Dollars
Space rental for 166.75 square-foot bay, at $1.75 per square foot	--	291.81	--	291.81
Cases per unit load	55	--	35	--
Unit loads per bay	32	--	36	--
Annual case storage at 10 stock turns	17,600	--	12,600	--
Total annual space cost per 1,000 cases	--	16.58	--	23.16

In-plant Transportation

Three types of transportation take place in the supplier plant: (1) from the end of the unitizer at the packing line to storage; (2) from the point of storage to the shipping dock; and (3) from the dock into the rail car or trailer. Transportation distances will vary in different plants, but the important cost variable (both between pallet and palletless handling and between the two unit load sizes) is the number of cases transported each trip. Transportation costs were calculated and analyzed in the context of the three transportation elements for pallet vs. palletless transportation as well as for the two unit load sizes.

Pallet Transportation

The unit load size for the three transportation elements is 60 cases on the 48- by 40-inch pallet and 39 cases on the 40- by 32-inch pallet. Labor costs, including fringe benefits, are based on $7.50 per hour and a counterbalanced forklift truck cost estimate of $1.90 per hour, for a total labor and equipment cost of $9.40 per hour. Table 4 shows that the supplier's in-plant transportation costs total $32.75 per 1,000 cases with use of 48- by 40-inch pallets and $50.38 per 1,000 cases with 40- by 32-inch pallets.

Palletless Transportation

The unit load size for the three transportation elements with a clamp lift truck is 55 cases for the 48- by 40-inch unit load and 35 cases for the 40- by 32-inch unit load. Labor costs are the same, $7.50 per hour including fringe benefits, while the forklift truck with clamp attachment cost estimate is $2.50 per hour. Table 5 shows that the in-plant transportation costs total $30.36 per

1,000 cases using 48- by 40-inch clamp loads and $47.71 per 1,000 cases using 40- by 32-inch clamp loads.

Table 4.--In-plant transportation cost with pallets

Cost element	Time	Cost
	Hours	Dollars
Labor at $7.50 per hour:		
Transport to storage	0.051	0.383
Transport to dock	.086	.645
Load carrier	.072	.540
Total time and cost	.209	1.568
Equipment at $1.90 per hour	.209	.397
Total labor and equipment cost per pallet trip	--	1.965
Cost per 1,000 cases:		
48- by 40-inch pallet at 60 cases	--	32.75
40- by 32-inch pallet at 39 cases	--	50.38

Table 5.--In-plant transportation costs without pallets

Cost element	Time	Cost
	Hours	Dollars
Labor at $7.50 per hour:		
Transport to storage	0.048	0.360
Transport to dock	.063	.472
Load carrier	.056	.420
Total time and cost	.167	1.252
Equipment at $2.50 per hour	.167	.418
Total labor and equipment cost per unit load trip	--	1.670
Cost per 1,000 cases:		
48- by 40-inch at 55 cases	--	30.36
40- by 32-inch at 35 cases	--	47.71

Material

Included in material cost is the unit load platform (pallet or slipsheet) as well as dunnage (box-type bumpers for railcars and stretch film for trailers). One problem in shipping two unit load sizes would be the mixing of the two sizes in railcars and trailers. Other considerations would be the development of layer patterns to fully utilize the space on the pallet or slipsheets and development of loading patterns to fully utilize space in the transportation vehicle. A second size unit load would require new loading patterns, layer quantities, and recommended order quantities for all items that may be shipped in smaller unit load quantities. Material cost will be discussed separately for pallet and slipsheet handling and shipping.

Material Cost--Pallet

Pallets are a major cost item and are of increasing concern among the shippers studied. One supplier had to replace 80 percent of a half-million-pallet inventory each year. Another supplier either lost or repaired 9.3 percent of its pallets every month. Another large firm, which pioneered pallet shipment, found that the cost per pallet trip had increased from 10 cents to $2.25 in the past 15 years. The major problems of pallet shipment are the quality of the pallets returned under the exchange program (hence high repair costs) and the possibility of the railroads phasing out the free return of pallets.

In this study no attempt was made to determine the cost of a larger pallet inventory when the two sizes are used. It would be essential to have a reserve of each size to meet variations in shipping requirements. If pallet shipments took place under ideal conditions, i.e., if pallet quality was similar to that of the former Grocery Pallet Council (GPC) licensed pallets, costs would decrease measurably. It is estimated that the cost per use would decrease by a six to one ratio, because of increased trips per pallet and lower repair costs. 3/

A different type of dunnage was used in railcars than in trailers. Box-type bumpers were used in railcars because they provided excellent product protection, facilitated unloading, and could be returned for reuse. The bumpers vary in thickness from 3 to 10 inches, and they vary in height, though they are usually about 40 inches high. They are placed between the rows of unitized product and in the center or door section when product is not hand loaded. It is difficult to return bumpers and pallets in trailer shipment, however, making the cost of such one-trip dunnage prohibitive. One firm cooperating in this study used stretch film for trailer loads. It was relatively inexpensive, added no weight, protected the product, and made the pallets easy to unload. As shown in table 6, the use of a second pallet size would add $9.68 in material cost per 1,000 cases. The increased material cost includes $3.60 for the pallet and $6.08 for dunnage used in shipment.

3/ "Pallet Council Campaign Adds Only One Member." Super Market News 26 (19): 44. May 9, 1977.

Table 6.--Plant material cost with 2 pallet sizes

Cost element	Pallet size	
	48 by 40 inches	40 by 32 inches
	Dollars	Dollars
Pallets:		
Cost per trip 1/	0.768	0.640
Cost per case 2/	.0128	.0164
Cost per 1,000 cases	12.80	16.40
Dunnage--railcars:		
Box-type bumpers--cost per trip 1/	2.011	1.798
Cost per railcar 3/	52.29	70.12
Cost per 1,000 cases 4/	15.56	24.97
Dunnage--trailers:		
Stretch film cost per unit load	.65	.53
Cost per trailer load 5/	14.30	15.90
Cost per 1,000 cases 6/	10.83	13.59
Average dunnage cost for rail and truck per 1,000 cases	13.20	19.28
Total plant material cost per 1,000 cases	26.00	35.68

1/ See appendix table 11 for details on cost, depreciation, loss, interest, repair, and discard.

2/ Based on 60 cases on the standard pallet (48 by 40 inches) and 39 cases on the small pallet (40 by 32 inches).

3/ Based on 26 bumpers per car with standard pallets and 39 bumpers with small pallets.

4/ Based on 3,360 cases per car with standard pallets and 2,808 cases per car with small pallets. See appendix table 12 for capacity computation.

5/ Based on 22 standard pallet loads and 30 small pallet loads per trailer.

6/ Based on 1,320 cases per trailer with standard pallets and 1,170 cases with small pallets. See appendix table 12 for capacity computation.

Material Cost--Palletless

In palletless handling, the product is usually loaded with a clamp forklift truck and placed on a slipsheet in the transport vehicle. The slipsheet is a one-trip platform, so the material cost depends only on the slipsheet cost and the number of cases. Use of the slipsheet eliminates the problem of pallet exchange associated with pallet shipment. The dunnage used for palletless shipment was the same as that used for shipment with pallets. The case capacity in palletless loaded railcars was lower than that in pallet loaded cars. As shown in table 7, the use of a second unit load size would increase material cost $7.60 per 1,000 cases.

Table 7.--Plant material cost with palletless handling of 2 unit load sizes

Cost element	Unit load size	
	48 by 40 inches	40 by 32 inches
	Dollars	Dollars
Platform:		
Slipsheet	0.60	0.40
Cost per case 1/	.0109	.0114
Cost per 1,000 cases	10.91	11.43
Dunnage--railcars:		
Box-type bumpers--cost per trip 2/	2.011	1.798
Cost per railcar 3/	52.29	70.12
Cost per 1,000 cases 4/	16.98	27.83
Dunnage--trailers:		
Stretch film cost per unit load	.65	.53
Cost per trailer load 5/	14.30	15.90
Cost per 1,000 cases 6/	11.82	15.14
Average dunnage cost for rail and truck per 1,000 cases	14.40	21.48
Total plant material cost per 1,000 cases	25.31	32.91

1/ Based on 55 cases on the standard slipsheet (48 by 40 inches) and 35 cases on the small slipsheet (40 by 32 inches).

2/ See appendix table 11 for details on initial cost, depreciation, interest, and number of uses.

3/ Based on 26 bumpers per car with large slipsheets and 39 with small slipsheets.

4/ Based on 3,080 cases with standard slipsheets and 2,520 cases with small slipsheets. See appendix table 12 for capacity computation.

5/ Based on 22 standard slipsheets and 30 small slipsheets per trailer.

6/ Based on 1,210 cases per trailer with standard slipsheets and 1,050 cases with small slipsheets. See appendix table 12 for capacity computation.

SUMMARY OF SUPPLIER COSTS

Based on data developed in this study, a supplier plant using pallets for storage and shipment would have increased costs totaling $43.52 per 1,000 cases, or an increase of nearly 44 percent, with the addition of a second size pallet (table 8). A supplier plant using palletless storage and shipment would have increased costs totaling $47.06 per 1,000 cases, or an increase of 54 percent, with the addition of a second size unit load. As shown in table 8, the added costs were significant in unitization, transport, and materials. The added supplier costs for a second size unit load shipped on pallets or slipsheets, $43.52 and $47.06 per 1,000 cases respectively, must be compared with an added warehouse cost of $6 per 1,000 cases for repalletizing from 48- by

Table 8.--Supplier costs associated with 1 unit load size, 48 by 40 inches, and with the addition of a second unit load size, 40 by 32 inches

Cost element	Pallets		Palletless	
	48 by 40 inches	40 by 32 inches	48 by 40 inches	40 by 32 inches
	Dollars per 1,000 cases			
Unitization	14.32	29.85	14.32	29.85
Storage	26.64	27.32	16.58	23.16
In-plant transport	32.75	50.38	30.36	47.71
Materials	26.00	35.68	25.31	32.91
Total	99.71	143.23	86.57	133.63

40-inch unit loads to 40- by 32-inch pallets.

It is not the intent of this study to compare the relative merits of pallets and slipsheets for shipping product from supplier to distribution warehouse. Additional considerations such as damage rates, weight, and space utilization need to be evaluated before comprehensive conclusions can be obtained.

TRANSPORT VEHICLE UTILIZATION

Although it would be necessary for suppliers to develop new loading patterns with smaller unit load sizes, this problem is not insurmountable. A greater problem would be encountered in achieving good space utilization when two unit load sizes are loaded in the same vehicle.

More labor is required to load and unload the smaller unit loads than is required with the standard unit loads because more loads are handled when smaller units are used. The weight of pallets with the two unit load sizes would be similar. The slightly lower case capacity of the smaller unit load theoretically would reduce space utilization. However, in practice truckers load the full allowable weight, even if it means handstacking on top of unit loads. There is a possibility of better space utilization with an alternate loading pattern for standard pallets. Pallet loads of product can be loaded with the 40-inch dimension facing in opposite directions, making it possible to place 22 pallet loads in a 42-foot trailer compared with only 20 pallets when all pallets are loaded with the 40-inch dimension facing out. Figure 2 shows the loading pattern in a 42-foot trailer with 48- by 40-inch and 40- by 32-inch unit loads.

Based on 60 cases per 48- by 40-inch unit load, the illustrated trailer with 22 unit loads would hold 1,320 cases. Without cross stacking, the trailer capacity would be 20 unit loads or 1,200 cases. The trailer capacity is 30 unit loads of the 40- by 32-inch dimension, and with 39 cases per load the trailer capacity would total 1,170 cases. As previously indicated, the number of cases can be increased by putting more cases on each unit load. There does not appear to be an appreciable cost disadvantage to using the second unit load for trailer shipment, particularly since trailers are normally loaded to the weight limitation by handstacking.

A railcar has sufficient width, 108 inches, to accommodate three 40 - by 32 -inch unit loads or two 48- by 40-inch loads. With the smaller unit load the 32-inch dimension would be exposed and with the large unit load, the 48-inch dimension would be exposed. Because product in small unit loads would be three-wide inside the railcar, the type of dunnage used would depend on the extent to which the 32-inch dimension is exceeded. For example, the space between rows will total 5 inches if the unit load is 32 inches wide. This is based on 108 inches inside the car, 96 inches for the product (three 32-inch loads), 1 inch between the product and outside walls on each side, and 5 inches between each row of product. A 4-inch bumper can be used to reduce damage and facilitate unloading. If the unit loads are 33 inches wide (1-inch case overhang on pallets), the space between rows is reduced to 3.5 inches between rows and a 3-inch bumper can be used. However, if the unit loads are

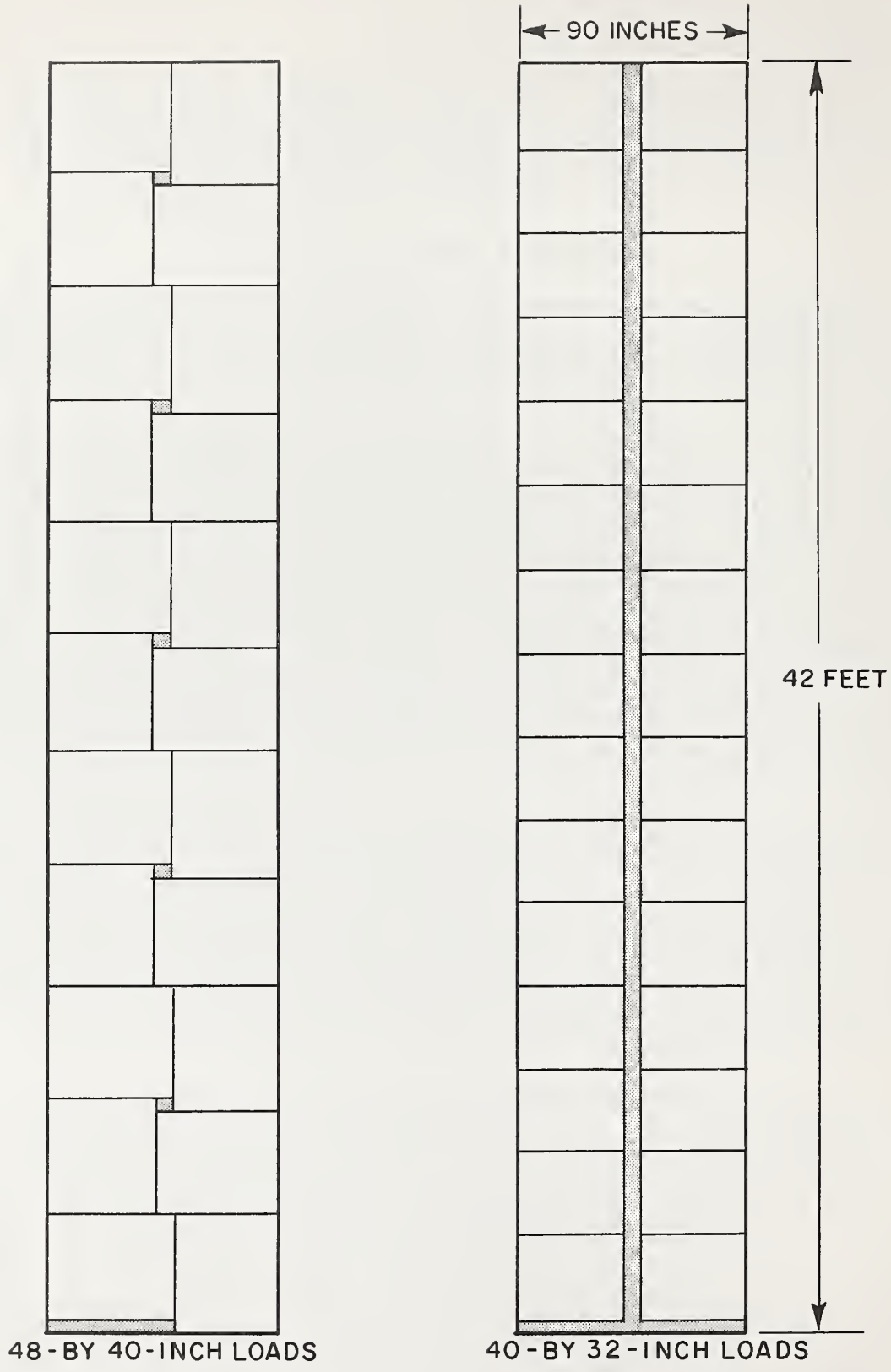

Figure 2.--Trailer loading pattern for 48- by 40-inch and 40- by 32-inch unit loads.

34 inches wide (2-inch case overhang on pallets) only 2 inches will remain between rows so that bumpers cannot be used. Use of the smaller unit load size with a 34-inch width is disadvantageous because bumpers cannot be used, though it is possible to use divider sheets or to enclose the unit load with stretch film.

It isn't likely that a railcar would ever be fully loaded with the 40- by 32-inch unit loads, and the shipper can adjust to any excessive overhang with different dunnage. The potential losses with the smaller unit load are its lower case capacity, the inconvenience of mixing two unit load sizes, and possibly the use of different dunnage. Assuming 20 percent of the cases are on small unit loads and the loss of capacity is 5 percent, then the net capacity loss is 1 percent. The rail freight structure is bracketed so that a small change in the car weight will not affect the rate. For example, the average unitized rail shipment was 65,000 pounds. The same rate is charged per hundred weight for loads from 60,000 to 80,000 pounds. A 1 percent loss of case capacity would reduce the loaded car weight only 650 pounds. The only significant loss in adding the smaller unit load is the cost of mixing the two size unit loads.

For purposes of this study, then, no significant additional out-of-plant transportation costs are projected with an additional unit load size. This conclusion is based only on the data developed in this study. Since additional supplier costs are so great for a smaller size unit load, it is highly unlikely that sufficient offsetting savings can be achieved in the distribution system.

APPENDIX

Table 9.--Estimated cost for palletizer and case diverter

Type of equipment	Initial cost	Anticipated life	Annual depreciation	Annual interest cost 1/	Annual operating cost	Space cost 2/	Total annual cost	Cost per 1,000 cases 3/
	Dollars	Years	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Palletizer-----	60,960	12	5,080	2,134	3,525	--	10,740	14.32
Case diverter--	3,000	10	300	105	150	350	905	1.21

1/ Annual interest equals half of purchase price times 7 percent interest charge.
2/ 200 square feet of space required for palletizer and diverter at $1.75 per square foot.
3/ Based on 125 cases per hour for 6,000 hours, or 750,000 cases annually.

Table 10.--Number of cases per layer for items stored on 48- by 40-inch and 40- by 32-inch pallets in food distribution warehouses

Product category, number of units, and unit size	Pallet size	
	48 by 40 inches	40 by 32 inches
	Number of cases per layer	
Baby foods:		
12 units, 32 oz	21	14
12 units, 13 oz	15	10
24 units, 4.75 oz	12	8
Cake mix:		
12 units, 32 oz	10	7
12 units, 22-1/2 oz	8	5
12 units, 18-1/2 oz	21	15
36 units, 6 oz	10	8
Coffee:		
Bag, 24 units, 1 lb	13	10
Can, 12 units, 2 lb	10	7
Can, 24 units, 1 lb	10	5
Instant, 12 units, 10 oz	10	5
Instant, 18 units, 8 oz	6	4
Instant, 24 units, 2 oz	6	4
Coffee creamer:		
12 units, 11 oz	14	8
Flour:		
Bag, 10 units, 5 lb	7	5
Bag, 12 units, 2 lb	8	6
Box, 12 units, 2 lb	13	8
Fruit, canned:		
24 units, 29 oz	10	5
24 units, 16 oz	15	10
Jelly and peanut butter:		
12 units, 32 oz	10	6
12 units, 28 oz	9	6
12 units, 18 oz	14	10
Juice, canned:		
12 units, 46 oz	8	5
12 units, 32 oz	10	7
8 units, 8 oz, 6 pack	14	10
Mayonnaise:		
12 units, 16 oz	14	8
12 units, 8 oz	19	14
Meat, canned:		
24 units, 12 oz	9	6
24 units, 5 oz	15	10
Pet food, canned:		
24 units, 14.75 oz	8	5
24 units, 6.5 oz	14	8

Table 10.--Number of cases per layer for items stored on 48- by 40-inch and 40- by 32-inch pallets in food distribution warehouses--Continued

Product category, number of units, and unit size	Pallet size	
	48 by 40 inches	40 by 32 inches
	Number of cases per layer	
Pickles:		
12 units, 32 oz	10	5
12 units, 24 oz	10	5
12 units, 22 oz	14	10
12 units, 16 oz	11	8
Sauces:		
12 units, 18 oz	11	8
Sirup:		
12 units, 24 oz	11	7
Soap, bar:		
72 units, 5 oz	17	10
48 units, 4.75 oz	22	10
Soft drink:		
24 units, 12 oz	10	7
Soup:		
48 units, 10.5 oz	10	7
24 units, 10.75 oz	10	7
Tomato paste, canned:		
24 units, 15 oz	15	10
48 units, 6 oz	18	10
Vegetables, canned:		
24 units, 16 oz	15	10
24 units, 8 oz	10	7
Vegetables and macaroni, dry		
24 units, 16 oz	10	6
24 units, 12 oz	15	8
24 units, 8 oz	10	8
Total	592	382
Number of items	49	49
Average number of cases per layer	12.08	7.80

Table 11.--Costs for pallets and box-type bumpers for grocery shipments 1/

Item	Initial cost	Loss and repair 2/	Depreciation 3/	Interest 4/	Handling and storage 5/	Total monthly charge	Cost per trip 6/
	Dollars						
Pallet, 48 by 40 inches---	6.00	3,000.00	2,500.00	262.50	--	5,762.50	0.768
Pallet, 40 by 32 inches---	5.00	2,500.00	2,083.33	218.75	--	4,802.08	.640
Box-type bumper, 48 by 40 inches------	8.00	--	10,000.00	204.17	4,875.00	15,079.17	2.011
Box-type bumper, 40 by 32 inches------	6.75	--	8,437.50	172.27	4,875.00	13,484.77	1.798

1/ Cost information based on internal records of cooperating firms.

2/ Based on 4 percent loss of 7,500 units shipped per month or 300 pallets, throw out of 200 pallets per month that are not repairable valued at $4.50 per standard pallet and $3.50 per small pallet and repair of 200 pallets per month at $1.50 each for both pallet sizes.

3/ Based on $30,000 per year for standard pallets, $25,000 per year for small pallets divided by 12 to provide monthly depreciation. The 7,500 box-type bumpers are used and depreciated in 6 months.

4/ For pallets, 7,500 units times purchase price times 7 percent divided by 12 to provide monthly cost. For bumpers, average monthly investment $35,000 for standard and $29,531.25 for small times 7 percent, divided by 12 equals monthly initial cost.

5/ Handling and storage costs are included in pallet systems costs and are added ($4,875) for box-type bumpers.

6/ Based on shipment of 7,500 units per month.

Table 12.--Optimum railcar and truck capacities for 2 unit load sizes on pallets and slipsheets

Unit load	Cases per unit load	Unit loads per car 1/	Unit loads per truck 2/	Cases per car	Cases per truck
	Number				
Pallet, 48 by 40 inches	60	56	22	3,360	1,320
Pallet, 40 by 32 inches	39	72	30	2,808	1,170
Slipsheet, 48 by 40 inches	55	56	22	3,080	1,210
Slipsheet, 40 by 32 inches	35	72	30	2,520	1,050

1/ Based on standard railcar, 50 feet long with unit loads stacked 2 high.
2/ Based on trailer, 42 feet long with unit loads stacked 1 high.

GPO 936-954